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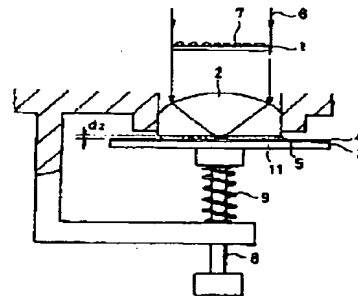
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(54) **ADHESION TYPE EXPOSURE DEVICE**

(57) Abstract:

PURPOSE: To make thin the film thickness of an immersion liquid interposed between a photo-mask or an optical projection system and a wafer and reduce the quantity of light absorbed, and to minimize and prevent exposure unevenness in an adhesion type exposure device.

CONSTITUTION: A wafer 3 coated with a photoresist 4 is fast stuck on an exposure lens 2 through an immersion liquid 5. A surface-active agent 11 is mixed into the immersion liquid 5 within a range that the photoresist 4 is not affected, and the surface-active agent 11 reduces the surface tension of the immersion liquid 5, and improves wettability. Accordingly, the film thickness d_2 of the immersion liquid is made thinner than the case where surface-active agent is not mixed.



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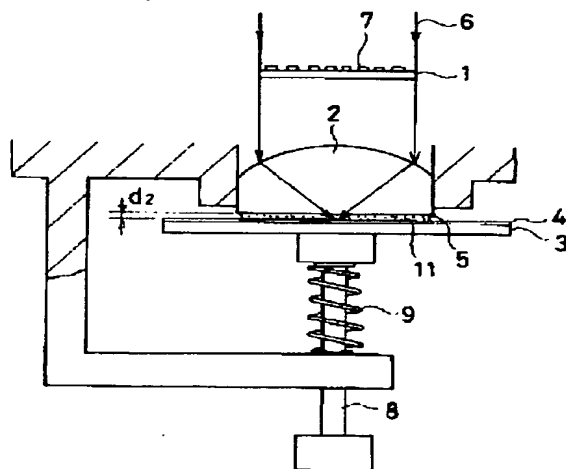
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(54) 【発明の名称】 密着型露光装置

(57) 【要約】

【目的】 密着型露光装置において、フォトマスクまたは投影光学系とウエハとの間に介在される浸液の膜厚を薄くして光の吸収量を少なくし、露光ムラを軽減防止することを目的とする。

【構成】 フォトリソスト4を塗布されたウエハ3を露光レンズ2に浸液5を介して密着させる。浸液5にはフォトリソスト4に影響を与えない範囲で界面活性剤11が混入されており、界面活性剤11は、浸液5の表面張力を減らし、濡れ性を高める。したがって、浸液の膜厚 d_2 は界面活性剤を混入しない場合より薄くなる。



【特許請求の範囲】

【請求項1】 フォトレジストを塗布されたウエハを投影光学系もしくはフォトマスクに浸液を介して密着させ、照射光の照射によりフォトマスクのパターンを前記フォトレジストに転写するようにした密着型露光装置において、前記浸液は前記フォトレジストに影響を与えない範囲で界面活性剤が混入されていることを特徴とする密着型露光装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、LSIの製造工程において、フォトマスク上のパターンをウエハ上に投影露光する露光装置、特に密着型露光装置に関するものである。

【0002】

【従来の技術】 レーザー光等を照射しフォトマスク上のパターンを投影光学系によってシリコンウエハ等の半導体基板上に投影露光するこの種の露光装置における露光方式としては、①密着（コンタクト）露光方式、②プロキシミティ露光方式、③反射型投影露光方式、④縮小

20 レンズ投影露光方式の4方式が知られている。
【0003】 このうち密着露光方式は、フォトマスク（または投影光学系）とウエハとを密着させて露光するもので、これらが完全に密着している場合には、フォトレジスト中の波長が屈折率分の1に短くなるため、回折の影響が少なく、高解像度の転写が得られるという特色を有している。この密着は真空吸着、静電チャック等によって行っている。しかし、完全な密着を実現することは極めて難しく、またフォトマスクとウエハとを機械的に接触させているためにウエハ表面の突起等によりフォ

30 トマスクに欠陥が生じ、その寿命を低下させると同時にデバイスの歩留りに影響を及ぼすといった問題があった。
【0004】 そこで、密着露光方式によるこのような問題を解決する方法としてフォトマスクとウエハ間に液体（浸液）を充填している。図2はウエハを浸液を介して投影光学系に密着させた場合を示すもので、1はフォトマスク、2は投影光学系の一部を構成する露光レンズ、3はフォトレジスト4が塗布されたウエハ、5は露光

【0005】

【発明が解決しようとする課題】 しかしながら、上述したような浸液5を使用した密着型露光装置においては、浸液5自身の膜厚ムラがあると、浸液5による照射光6の吸収量にムラが生じるため、コンタクト露光されたフォトレジスト4のパターンが的確に露光されている部分とそうでない部分とが生じてしまうという問題があった。したがって、このような露光ムラの発生を防止するため、浸液5の濡れ性を高めて表面張力を下げ、膜厚 d_1 を極力薄くすることが望まれている。

10 【0006】 本発明は上述したような従来の問題点および要望に鑑みてなされたもので、その目的とするところは、浸液の膜厚を薄くし、浸液による露光ムラを軽減防止し得るようにした密着型露光装置を提供することにある。

【0007】

【課題を解決するための手段】 本発明は上記目的を達成するため、フォトレジストを塗布されたウエハを投影光学系もしくはフォトマスクに浸液を介して密着させ、照射光の照射によりフォトマスクのパターンを前記フォ

【0008】

【作用】 本発明において界面活性剤は浸液の濡れ性を高め、表面張力を下げる。したがって浸液の膜厚を薄くする。

【0009】

【実施例】 以下、本発明を図面に示す実施例に基づいて詳細に説明する。図1は本発明に係る密着型露光装置の一実施例を示す要部の断面図である。なお、図中図2と同一構成部品のものに対しては同一符号を以て示し、その説明を省略する。

【0010】 本実施例は投影光学系にウエハを密着させた場合を示すもので、フォトマスク投影光学系の一部を構成する露光レンズ2とウエハ3との間に介在される純水等の浸液5に界面活性剤11を混入したものである。

40 【0011】 界面活性剤11としては、陽イオン性、陰イオン性、非イオン性等種々のものが使用可能であるが、屈折率が浸液5と同程度で光の吸収が少なく、またフォトレジスト4を溶かしたりすることのない範囲で混入されることが望ましい。特に、陽イオン性のうち四級アンモニウム塩系は、濡れ性も高く、レジストへの影響も少なく、光の吸収も少ないため好ましい。

【0012】 かくしてこのような構成においては界面活性剤11が浸液5の表面張力を減らして濡れ性を高めるため、ウエハ3を所定圧力にて露光レンズ2に圧接した際、浸液5の膜厚 d_2 を図2に示した従来装置と比較して薄くする（ $d_2 < d_1$ ）ことができ、また膜厚が薄くなれば光の吸収量も少なくなるので、これに比例して光

きるものである。

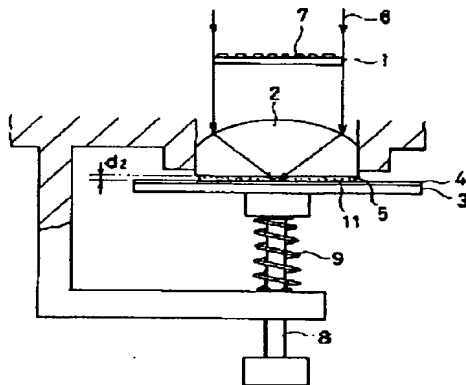
【0013】

【発明の効果】以上説明したように本発明に係る密着型露光装置によれば、浸液に界面活性剤を混入することにより、浸液自身の表面張力を減らして濡れ性を向上させるようにしたので、浸液の膜厚ムラを薄くすることができる。したがって、浸液の膜厚ムラが小さく、光の吸収を少なくすることができ、浸液による露光ムラを軽減防止することができる。

【図面の簡単な説明】

【図1】本発明に係る密着型露光装置の一実施例を示す要部の断面図である。

【図1】



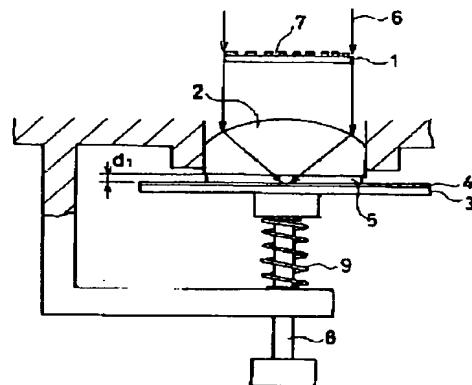
【図2】密着型露光装置の従来例を示す要部の断面図である。

【符号の説明】

- 1 フォトマスク
- 2 露光レンズ
- 3 ウエハ
- 4 フォトレジスト
- 5 浸液
- 6 照射光
- 7 マスク
- 11 界面活性剤

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【図2】



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(54) Title of Invention: **CONTACT EXPOSURE SYSTEM**

(57) Abstract

PURPOSE: To provide a contact exposure system that reduces the film thickness of an immersion liquid that is interposed between a wafer and a photomask or a projection optical system, thereby reducing the amount of light absorbed and reducing and preventing exposure unevenness.

CONSTITUTION: A wafer 3, which is coated with a photoresist 4, is brought into close contact with an exposure lens 2 through an immersion liquid 5. A surfactant 11 is mixed into the immersion liquid 5 within a range that does not affect the photoresist 4, thereby reducing the surface tension and increasing the wettability of the immersion liquid 5. Accordingly, the film thickness d_2 of the immersion liquid is reduced more than the case wherein the surfactant is not mixed in.

CLAIMS

1. A contact exposure apparatus that brings a wafer, which is coated with a photoresist, into close contact with a projection optical system or a photomask through an immersion liquid, and then transfers a pattern of the photomask to the photoresist by irradiating an irradiation light, wherein

a surfactant is mixed into the immersion liquid within a range that does not affect the photoresist.

DETAILED EXPLANATION OF THE INVENTION

[0001]

INDUSTRIAL FIELD OF APPLICATION

The present invention relates to an exposure apparatus that projects and exposes a pattern of a photomask onto a wafer in an LSI fabrication process, and more particularly relates to a contact exposure apparatus.

[0002]

RELATED ART

With the kind of exposure apparatus that irradiates laser light and the like to project and expose the pattern of a photomask onto a semiconductor substrate, such as a silicon wafer, by using a projection optical system, four exposure systems are known: (1) a contact exposure system, (2) a proximity exposure system, (3) a reflection type projection exposure system, and (4) a reduction lens projection exposure system.

[0003]

Among these systems, the contact exposure system performs exposure by bringing the photomask (or the projection optical system) and the wafer into close contact, and the wavelength within the photoresist therefore is reduced by a factor of the inverse of the refractive index if they are completely in contact; consequently, the impact of diffraction is small and a high resolution transfer is obtained. This contact is accomplished by a vacuum chuck, an electrostatic chuck, or the like. However, there is a problem in that it is extremely difficult to realize complete contact; further, there is a problem in that the photomask and the wafer are mechanically brought into contact, and protrusions and the like on the front surface of the wafer therefore cause defects in the photomask, which reduces the life of the photomask while at the same time adversely impacting the yield of devices.

[0004]

Accordingly, a liquid (immersion liquid) is filled between the photomask and the wafer as a method to solve the problems caused by a contact exposure system. FIG. 2 shows a wafer

that has been brought into close contact with a projection optical system through an immersion liquid; therein, 1 is the photomask, 2 is an exposure lens that constitutes part of the projection optical system, 3 is the wafer, which is coated by a photoresist 4, 5 is the immersion liquid, which is filled between the exposure lens 2 and the wafer 3, 6 is an irradiation light that irradiates a pattern 7 of a photomask 1 and exposes the photoresist 4, 8 is a holding body that holds the wafer 3, and 9 is a compression coil spring that urges the holding body 8 upward and pushes the wafer 3 against the exposure lens 2 with a prescribed pressure. The shorter the wavelength of the irradiation light 6, the lesser the impact of diffraction, and consequently a laser apparatus, such as an excimer laser, is used as the light source. It is preferable that the immersion liquid 5 has a refractive index approximately the same as the photoresist 4, absorbs little light, and does not dissolve the photoresist 4; normally, pure water is used.

[0005]

PROBLEMS SOLVED BY THE INVENTION

Nevertheless, in a contact exposure apparatus that uses the immersion liquid 5 as discussed above, there is a problem in that unevenness arises in the amount of the irradiation light 6 absorbed by the immersion liquid 5 if there is film thickness unevenness in the immersion liquid 5 itself, which unfortunately leads to portions where the pattern of the contact exposed photoresist 4 is precisely exposed and portions where it is not. Accordingly, to prevent the occurrence of such exposure unevenness, it is preferable to increase the wettability and lower the surface tension of the immersion liquid 5, as well as to reduce a film thickness d1 thereof as much as possible.

[0006]

The present invention considers the problems and needs of the conventional art discussed above, and it is an object of the present invention to provide a contact exposure apparatus that can reduce and prevent exposure unevenness caused by the immersion liquid by reducing the film thickness thereof.

[0007]

MEANS FOR SOLVING THE PROBLEMS

To achieve the abovementioned objects, the present invention is a contact exposure apparatus that brings a wafer, which is coated with a photoresist, into close contact with a projection optical system or a photomask through an immersion liquid, and then transfers a pattern of the photomask to the photoresist by irradiating an irradiation light, wherein a surfactant is mixed into the immersion liquid within a range that does not affect the photoresist.

[0008]

MODE OF OPERATION

In the present invention, the surfactant increases the wettability and reduces the surface tension of the immersion liquid. Accordingly, the film thickness of the immersion liquid is reduced.

[0009]

EMBODIMENTS

The following explains the present invention in detail, based on the embodiments shown in the drawings. FIG. 1 is a cross sectional view of the principle parts of one embodiment of a contact exposure apparatus according to the present invention. Furthermore, constituent parts that are identical to those in FIG. 2 are assigned the same symbol, and the explanations thereof are omitted.

[0010]

The present embodiment describes a case wherein a wafer is brought into close contact with a projection optical system; in this case, a surfactant 11 is mixed into an immersion liquid 5, such as pure water, that is interposed between a wafer 3 and an exposure lens 2, which constitutes part of a photomask projection optical system.

[0011]

Various types of surfactants can be used for the surfactant 11, such as cationic, anionic, and nonionic types, but it is preferable that the surfactant used has a refractive index approximately the same as the immersion liquid 5, absorbs little light, and mixes in within a range that does not dissolve a photoresist 4. In particular, among cationic types, a quaternary ammonium salt is preferable because it has high wettability, has little impact on the resist, and absorbs little light.

[0012]

Thus, in such a constitution, the surfactant 11 enhances wettability by reducing the surface tension of the immersion liquid 5; consequently, it is possible to reduce a film thickness d_2 of the immersion liquid 5 ($d_2 < d_1$), compared with the conventional apparatus shown in FIG. 2, when the wafer 3 pressure contacts the exposure lens 2 at a prescribed pressure; in addition, the lesser the film thickness, the lesser the amount of absorbed light, and therefore it is possible to reduce the unevenness in the absorption of light in proportion to the film thickness, and to reduce and prevent exposure unevenness.

[0013]

EFFECTS OF THE INVENTION

According to the contact exposure apparatus of the present invention as explained above, mixing the surfactant into the immersion liquid reduces the surface tension of the immersion

liquid itself and thereby improves wettability, and it is therefore possible to reduce the film thickness of the immersion liquid. Accordingly, it is possible to reduce the film thickness unevenness and the light absorption of the immersion liquid, which makes it possible to reduce and prevent exposure unevenness caused by the immersion liquid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of the principle parts of one embodiment of a contact exposure apparatus according to the present invention.

FIG. 2 is a cross sectional view of the principle parts of a conventional example of a contact exposure apparatus.

EXPLANATION OF SYMBOLS

- | | |
|----|-------------------|
| 1 | Photomask |
| 2 | Exposure lens |
| 3 | Wafer |
| 4 | Photoresist |
| 5 | Immersion liquid |
| 6 | Irradiation light |
| 7 | Mask |
| 11 | Surfactant |